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(54) Apparatus for producing sodium hypochlorite

(57) Sodium hypochlorite is prepared by electrolysing a solution of salt 13. The temperature of the solution 13 is monitored e.g. 5, sensor (29) and a refrigerating coil 17 is actuated to maintain the temperature at a prescribed value, thus reducing decomposition.

Electrolysis may occur in a vessel 12 mounted in an upper chamber of a cabinet 11, and communicating with a cock 24 on the cabinet exterior. A closure plate (16, Figure 2) enhances stability. Apertures (16a) for the escape of hydrogen preferably have porous plugs (39). The chamber 12 preferably has an insulating jacket 21. There may also be a reservoir (41, Figure 6) with an insulating jacket (43).

A further chamber 51 with a stirrer 53 for preparing salt solution may be mounted on the cover plate (16), and communicate with the electrolysis chamber 12.

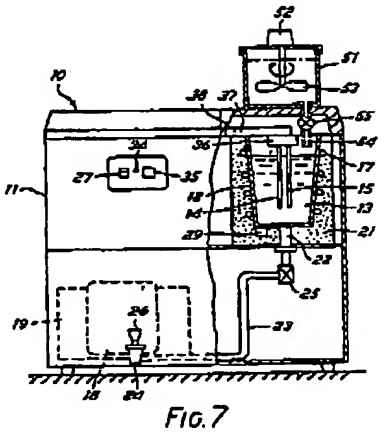

FIG. 7

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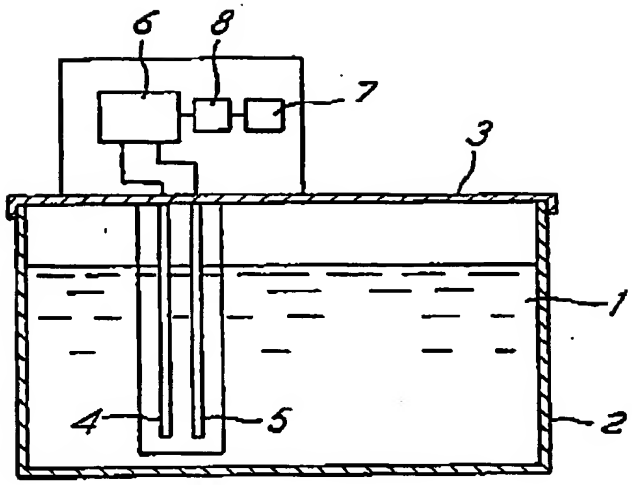

FIG.1

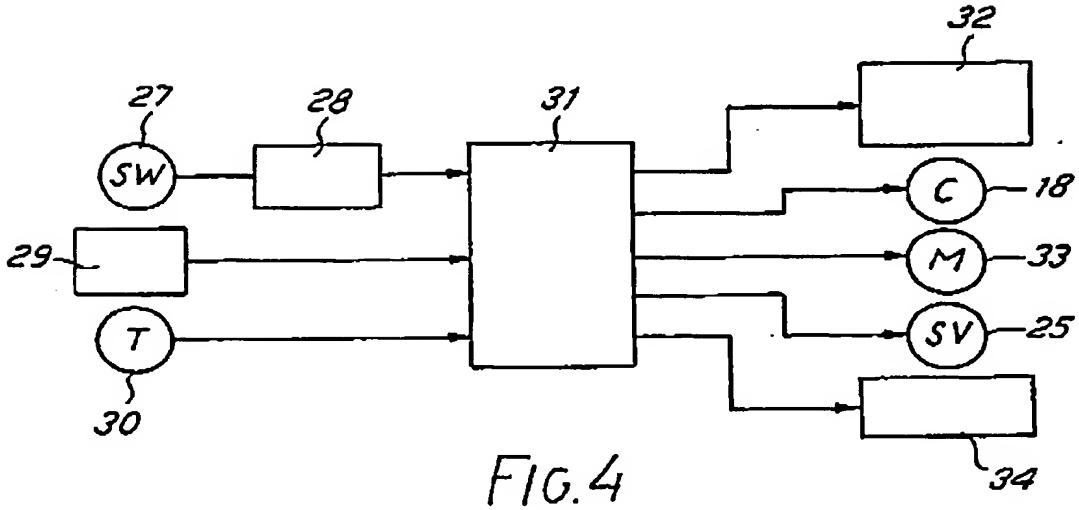

FIG.4

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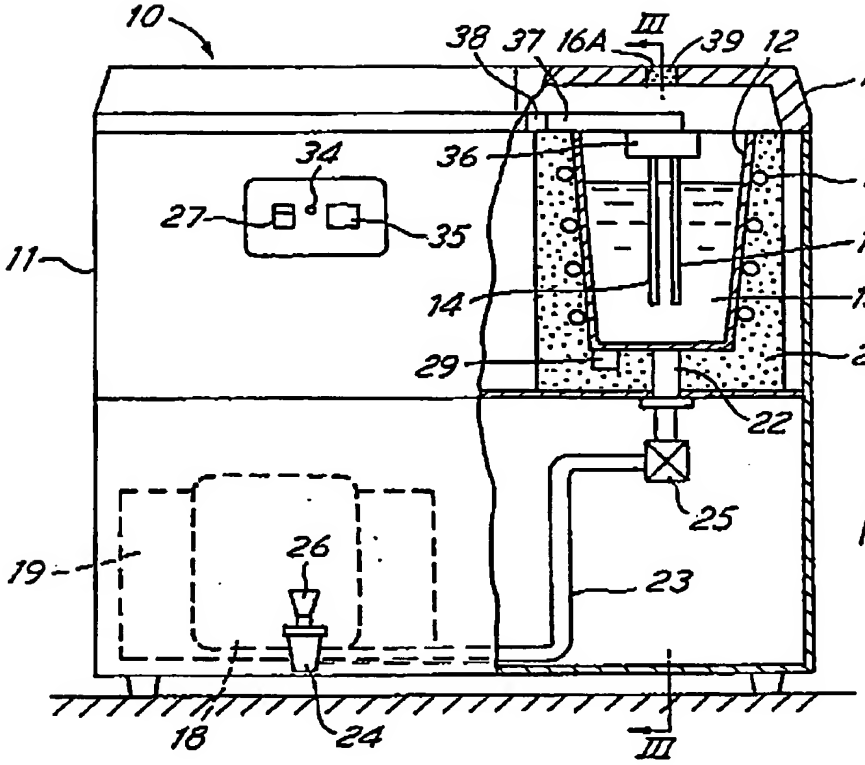

FIG.2

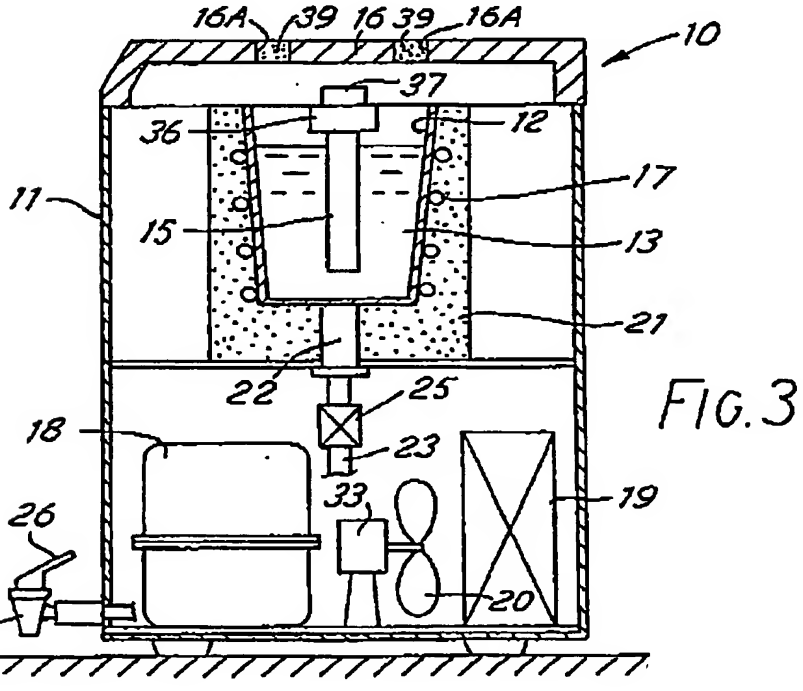

FIG.3

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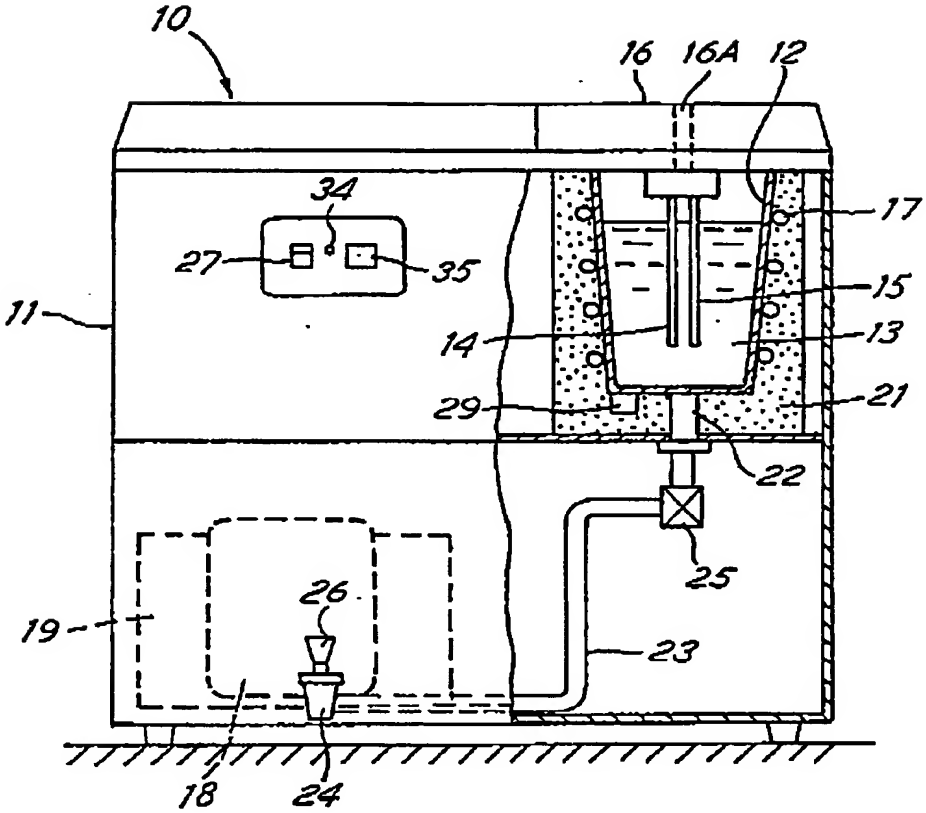

FIG.5

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4/7

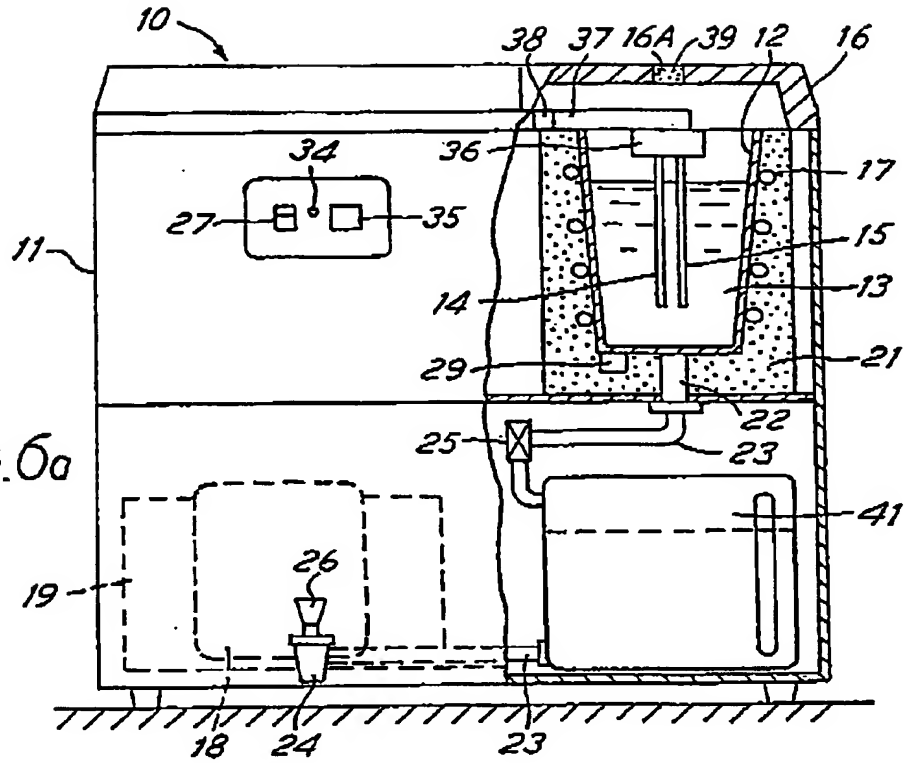

FIG.6a

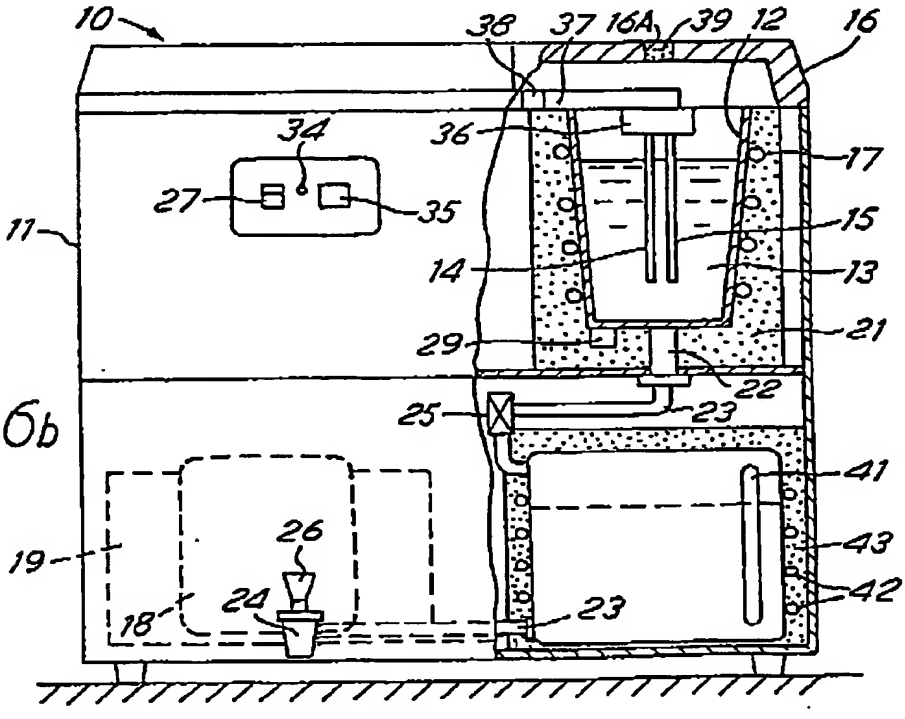

FIG.6b

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5/7

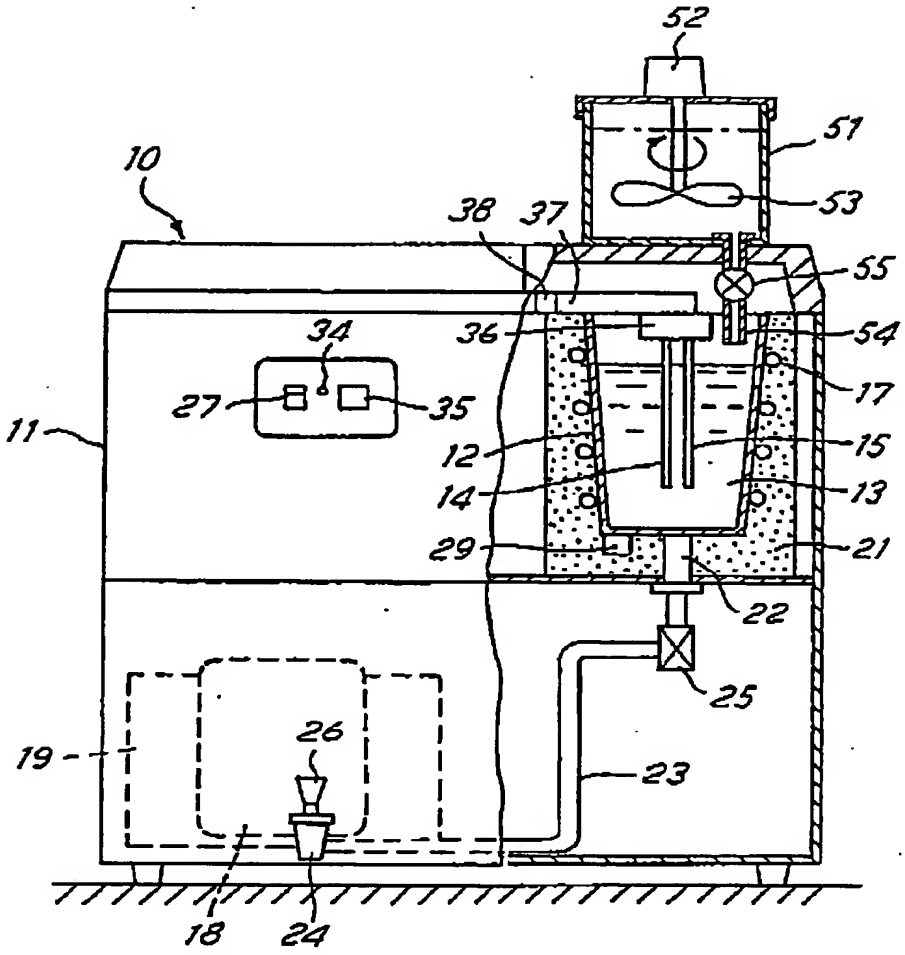

FIG. 7

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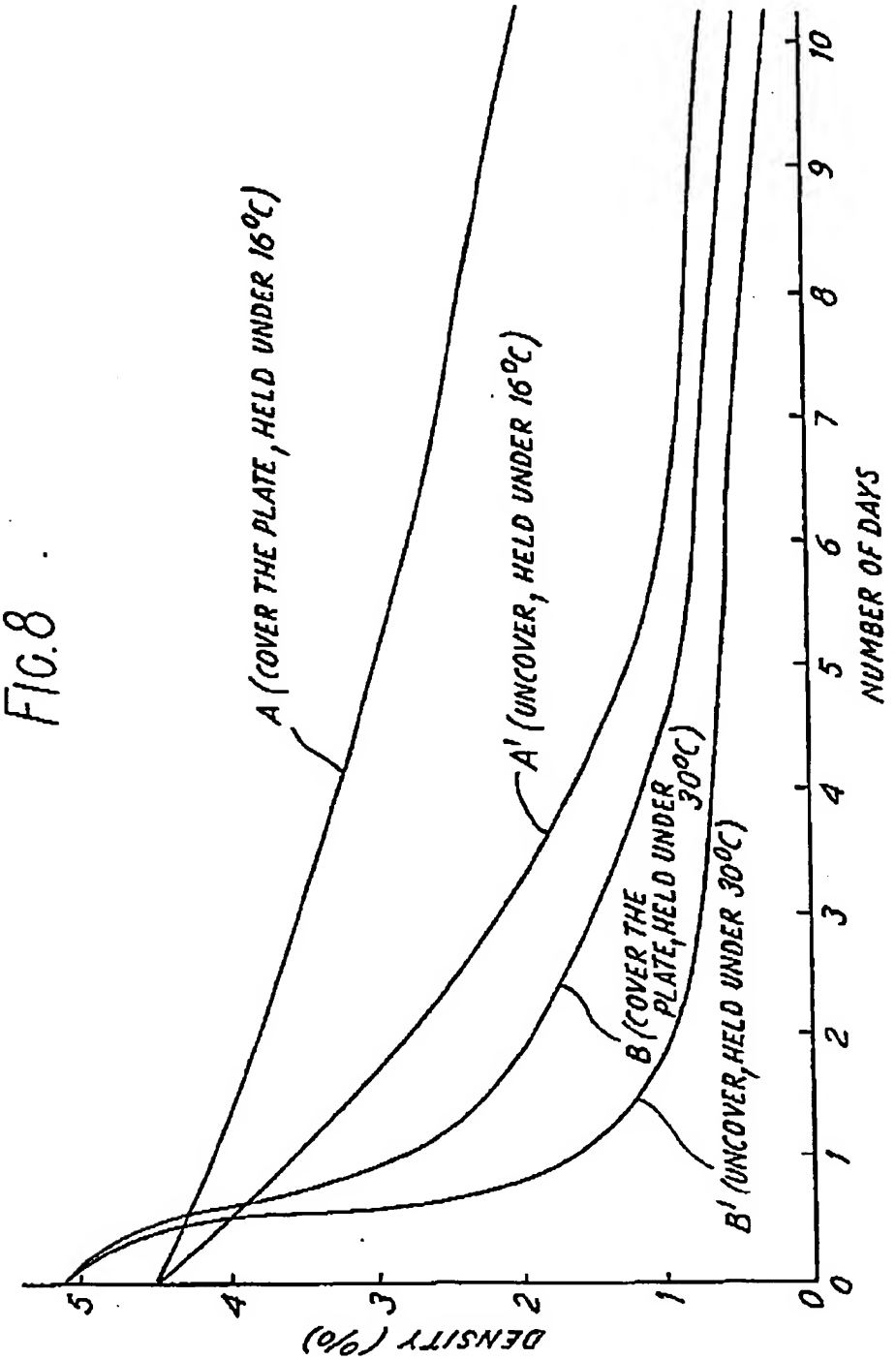
6/7

FIG.8



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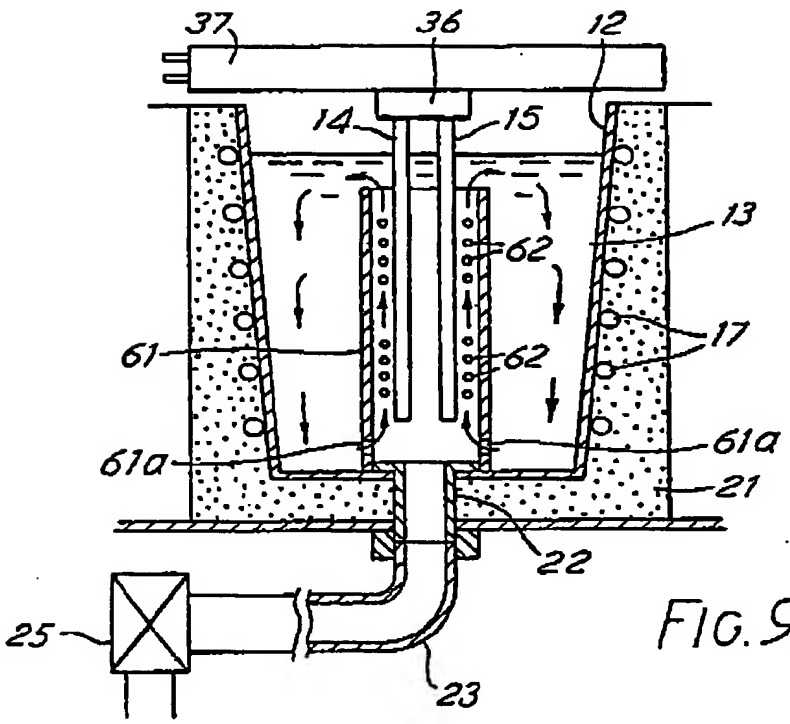

FIG. 9a

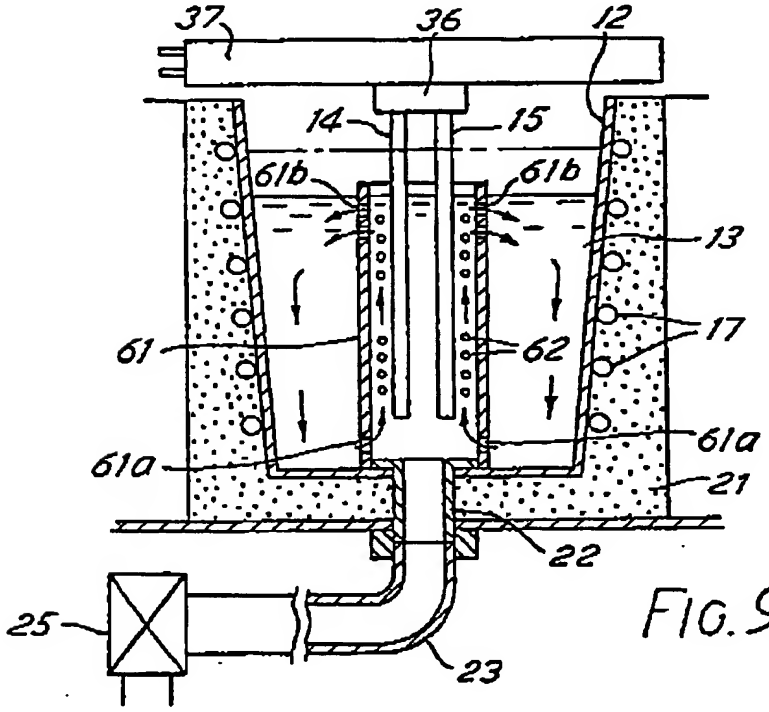

FIG. 9b

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APPARATUS AND METHOD FOR PRODUCING SODIUM HYPOCHLORITE

This invention relates to an apparatus and method for producing sodium hypochlorite, which is widely used for sterilising or disinfecting foodstuffs.

Sodium hypochlorite is normally produced industrially as a concentrated liquid (e.g. 12% w/w) which is diluted (e.g. to 200 p.p.m.) shortly before use. But the concentrated sodium hydrochlorite is unstable, so that it is generally necessary to add a stabiliser. But this reduces the sterilising and cleaning power.

A known apparatus intended to ameliorate such disadvantages is shown in Fig. 1. It comprises a vessel 2 for a solution of salt 1; a cover plate 3; a pair of electrodes 4,5 fixed to the cover plate 3 so that they can project into the salt solution 1; and power supply and control means for the electrodes (comprising a rectifier 6, transformer 8 and timer 7), all mounted on the upper side of the cover plate 3.

For operation, the vessel 2 is charged with salt solution 1 and the cover plate 3 is put in place, so that the electrodes 4,5 are partially immersed in the solution 1. Electrolysis is effected for a set time, under control of the timer 7. The salt solution 1 is thus electrolysed to form sodium hypochlorite according to the formula:

$$NaCl + H_2O \rightarrow NaClO + H_2.$$

During the electrolysis, heat is generated, so that

the temperature of the liquid rises. This reduces the efficiency of formation of hypochlorite. Furthermore, if a high concentration of hypochlorite is required, not only must the power supply and electrodes be large, but the generation of heat is very great. Thus, the maximum concentration of sodium hypochlorite it is practicable to produce with such apparatus is around 1%. Furthermore, in forming a relatively concentrated solution, quite a large volume of hydrogen is produced. Therefore the cover plate 3 must have a venting hole. However, some mist containing sodium hypochlorite is formed within the vessel 2, and flows out with the hydrogen gas, causing pollution problems such as a disagreeable odour.

According to the invention there is provided an apparatus for producing sodium hypochlorite comprising:

an electrolysis vessel for electrolysis of a solution of salt;

a pair of electrodes extending within said vessel for said electrolysis;

refrigerating means associated with the vessel for refrigerating a solution within said vessel;

a temperature sensor arranged to detect the temperature of a solution in said vessel and produce an output signal; and

control means for controlling said refrigerating means in response to said output signal. Preferably the vessel is mounted within a cabinet. Preferably there is a cover

plate. Venting outlets for hydrogen are required, and preferably have porous plugs for restraining the escape of mist.

In another aspect the invention provides a method of producing sodium hypochlorite comprising electrolysing a salt solution while monitoring the temperature thereof and cooling the solution to maintain its temperature below a predetermined value.

It preferably employs apparatus according to the first aspect.

Some embodiments of the invention will now be described in greater detail with reference to the accompanying drawings in which:

Fig. 1 shows a known apparatus that has already been described;

Fig. 2 is a partly sectional elevation of apparatus according to a first embodiment of the invention;

Fig. 3 is a section on III-III in Fig. 2;

Fig. 4 is a schematic circuit diagram of control means for the first embodiment;

Fig. 5 is a view similar to Fig. 2 but showing a modified embodiment;

Fig. 6a is a view similar to Fig. 2 but showing a further embodiment;

Fig. 6b is a like view showing a slightly modified version of the Fig. 6a embodiment;

Fig. 7 is a like view of a third embodiment;

Fig. 8 is a graph showing the change in concentration of sodium hypochlorite;

Fig. 9a is a view similar to Fig. 2 but showing a fourth embodiment; and

Fig. 9b is a like view showing a slightly modified embodiment.

Figs. 2 and 3 show a first embodiment of apparatus for producing sodium hypochlorite. An outer casing 11 has an upper opening, and a horizontally extending separating plate (S) which divided into an upper chamber (U) and a lower, machinery chamber (M). A cup-shaped vessel 12 is mounted in the upper chamber (U). A pair of titanium electrodes 14,15 extend into the interior of the vessel 12. In this embodiment, the electrodes 14,15 extend from a plug 37 which is mounted through a block 36. The casing 11 has a plug socket 38 for connection to an electric supply. The casing 11 is closed by a removable cover plate 16, suitably formed of a plastics resin. (In the modified embodiment of Fig. 5, the electrodes 14,15 are mounted on the cover plate 16'.)

The cover plate 16 has a plurality of venting holes 16a. In this embodiment there are two such holes. They may be provided with plugs 39, suitably of plastics foam or other macromolecular blown materials (e.g. urethane foam) to produce pollution problems, e.g. by filtering out mist droplets.

Refrigerating means comprises a refrigerating tube 17

which extends around the periphery of the vessel 12; and a compressor 18 and condenser 19 which are coupled to the tube 17 but are located in the machine chamber (M). The vessel 12 and refrigerating tube 17 are covered in insulating material 21, such as urethane foam, to prevent heat transfer. The machine chamber (M) is ventilated by a fan 20 driven by a motor 33.

At the bottom of the vessel 12 there is an outlet conduit 23 coupled via a coupling 22. It communicates with a cock 24 externally of the casing 11. The conduit 23 has an electromagnetic valve 25 for controlling flow through it. This valve 25 is normally closed while sodium hypochlorite is being produced in the vessel 12, and is then opened so that the solution can be drawn off via the pipe 23 and cock 24, controlled by the handle 26. In the modification shown in Fig. 6a, there is a storage tank 41 intermediate the valve 25 and the cock 24, within the machine chamber (M). This tank 41 may be insulated (43) and refrigerated (42) as shown in Fig. 6b, so that the solution can be stored under stable conditions.

Fig. 4 shows a control means comprising a power source 28 (including a transformer and rectifier), controlled by a switch 27; a timer 30; a temperature sensor 29; and a controller 31. The control means may be mounted on or in the upper chamber (U), and be arranged to control the operation of the compressor 18, the ventilation motor 33, the valve 25, and the supply of current to the electrodes

in an electrolysis circuit 32.

Fig. 2 shows the switch 27 mounted so as to be accessible externally of the casing 11. The temperature sensor 29 is mounted on the exterior of the chamber 12, on the bottom, for sensing the solution temperature. It provides an input signal to the controller 31. This provides a control signal to operate the compressor 18 and ventilator motor 33. The timer 30 causes the controller 31 to actuate the electrolysis circuit 32 for a predetermined time. A time display 35 may indicate the remaining time for which electrolysis will continue. There may be a warning light 34 for indicating abnormal conditions, e.g. if the electrodes become disconnected or the current is reduced below a threshold value.

For operation, the cover plate 16 is removed and water and salt are charged into the vessel 12 and agitated. (Alternatively a solution of salt can be poured in, possibly without removing the cover plate 16 by means of the holes 16a.) The electrodes 14,15 are arranged to extend into the solution, and the cover plate 16 is put back on (if necessary).

Fig. 7 shows an embodiment having a solution forming vessel 51 mounted on the cover plate 16. It includes an agitating device, in this example a motor 42 driving a paddle 53. The resulting solution can pass into the vessel 12 through a conduit 54 controlled by a solenoid valve 55. This valve 55 and the motor 52 may be controlled by the

controller 31 (Fig. 4).

During electrolysis of a salt solution in the vessel 12, the outlet conduit 23 is closed by the valve 25. The process produces sodium hypochlorite and hydrogen gas. The gas escapes through the holes 16a. If these have foam plugs, mist is filtered out.

The electrolytic process generates heat, so that the solution 13 and vessel 12 tend to heat up. This is detected by the sensor 29. If the temperature exceeds a predetermined value (programmed into the controller 31) the compressor 18 of the refrigerating means is actuated so that refrigerant is circulated through the refrigerating tube 17. The refrigeration controls the decomposition of the sodium hypochlorite, and allows its concentration to increase gradually. Thus in an example of a practical embodiment, the temperature of the solution was held around 15°C by use of the refrigeration. Electrolysis was continued for 12 hours to produce a 4% solution of sodium hypochlorite.

After the preset time, the current supply to the electrodes 14,15 ceases, and the compressor 18 and fan 20 are switched off by the controller 31. If the cock 24 is opened, a concentrated solution of sodium hypochlorite can be dispensed. It may subsequently be diluted as required, e.g. to 200 p.p.m..

The concentrated solution can be stored in the apparatus. Heat transfer between the stored solution and

the exterior is minimised by the insulation 21 and cover plate 16. Thus the decomposition of the product can be kept small. Fig. 8 shows the effect of the use of the invention. Curve A shows the change in concentration of a solution of sodium hypochlorite when stored in apparatus embodying the present invention, at 16°C. Curve A' shows the effect of storage uncovered (i.e. without the cover 16). Curves B and B' are corresponding curves relating to storage in prior art apparatus with and without a cover, at a temperature of 30°C. The marked effect of (1) maintaining the temperature at 16°C and (2) providing a cover are clearly illustrated.

It is possible for there to be marked temperature gradients within a vessel of solution, so that heat transfer to the refrigerating tube 17 does not occur efficiently. Fig. 9 shows apparatus that deals with this problem. A cylindrical element 61 surrounds the electrodes 14,15. and is spaced from them. At the bottom, the element 61 is connected to the coupling 22. Its lower region also has a plurality of holes 61a so that solution can pass into its interior from the body of the solution. Its upper end may be below the liquid level in the container. Alternatively, flow communication can be established by means of upper holes 61b, as shown in Fig. 9b. During electrolysis, hydrogen bubbles from the electrodes, and creates an upward flow within the element 61. This enhances the mixing of the solution by convection, and thus

greatly reduces temperature differences within the solution.

The illustrated embodiments have been described by way of example only, and the skilled reader will understand that the invention is not restricted thereto. For example, features described in connection with one embodiment may be applied to another.

CLAIMS:

1. An apparatus for producing sodium hypochlorite comprising:

an electrolysis vessel for electrolysis of a solution of salt;

a pair of electrodes extending within said vessel for said electrolysis;

refrigerating means associated with the vessel for refrigerating a solution within said vessel;

a temperature sensor arranged to detect the temperature of a solution in said vessel and produce an output signal; and

control means for controlling said refrigerating means in response to said output signal.

2. The apparatus of claim 1 wherein said vessel is mounted within a cabinet and has an outlet conduit for discharging the solution, leading to a cock which is affixed to said cabinet.

3. The apparatus of claim 2 having an electromagnetic valve arranged to control the flow through said conduit.

4. The apparatus of claim 3 wherein a storage tank is disposed on the outlet side of said valve.

5. The apparatus of claim 4 wherein said storage tank is thermally insulated.

6. The apparatus of any preceding claim having a removable cover plate over the vessel, the plate having a plurality of through-holes.

7. The apparatus of claim 6 wherein said holes have plugs of foamed plastics material.

8. The apparatus of claim 6 or 7 wherein the vessel is mounted within a cabinet with an upper opening, and the cover plate extends over said opening.

9. The apparatus of any preceding claim wherein said vessel is thermally insulated.

10. The apparatus according to any preceding claim which further comprises a device for preparing a solution of salt coupled to said vessel for feeding said solution to it.

11. The apparatus of claim 9 wherein said solution preparing device comprises a second vessel for receiving water and salt, and means for agitating the water and salt to encourage solution.

12. The apparatus according to any preceding claim having a cylindrical element surrounding the electrodes at a distance and provided with a plurality of holes in a lower portion.

13. The apparatus of claim 12 wherein said cylindrical element is provided with a plurality of holes in an upper end portion.

14. An apparatus for producing sodium hypochlorite substantially as any herein described with reference to and as illustrated in the accompanying drawings except Fig. 1.

15. A method of producing sodium hypochlorite comprising electrolysing a salt solution while monitoring the temperature thereof and cooling the solution to maintain

its temperature below a predetermined value.

16. A method according to claim 15 which employs apparatus according to any of claims 1 to 14.

17. A method of producing sodium hypochlorite substantially as any herein described with reference to and as illustrated in the accompanying drawings except Fig. 1.